May 26, 1964 D. E. REED ETAL 3,134,870

PERMANENT MAGNET PROXIMITY SWITCH

Filed June 15, 1962 3 Sheets-Sheet 1

FIG. 1

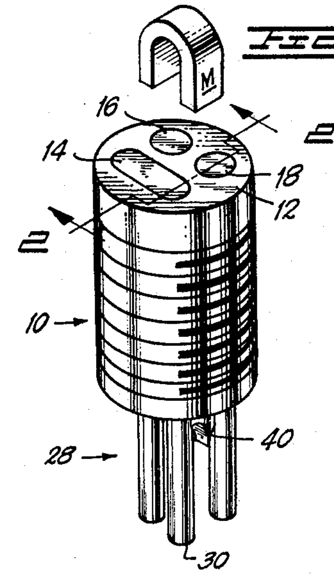


FIG. 2.

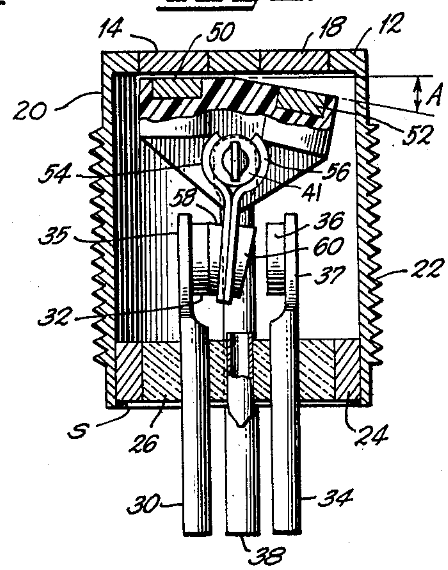


FIG. 3.

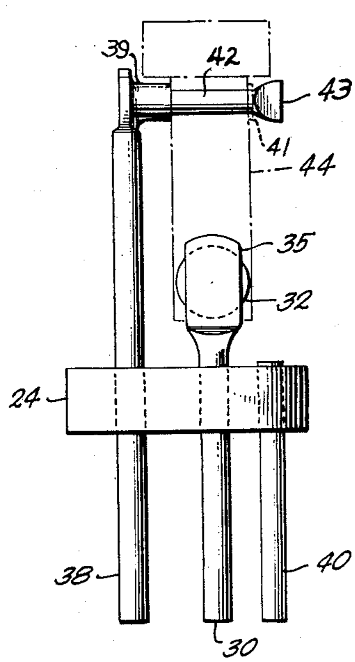
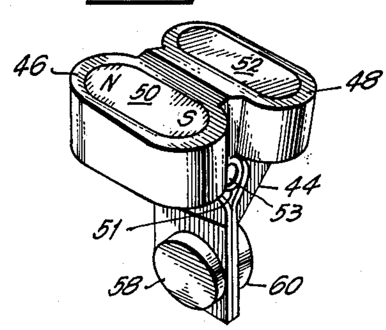


FIG. 4.



INVENTORS
DONALD E. REED
STANLEY F. REED

BY [signature]
ATTORNEY

PERMANENT MAGNET PROXIMITY SWITCH

Filed June 15, 1962 3 Sheets-Sheet 2

FIG. 5.

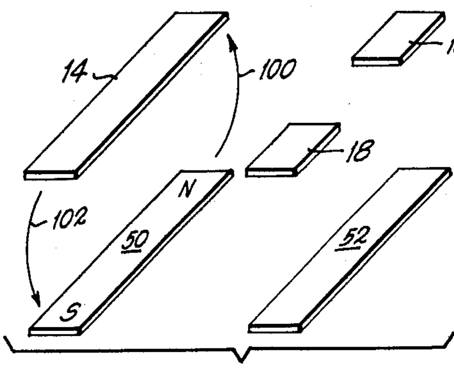


FIG. 6.

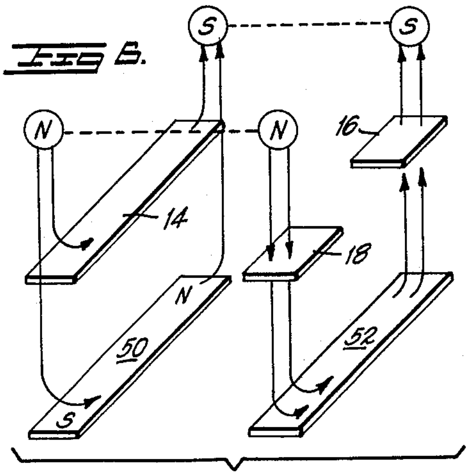


FIG. 7.

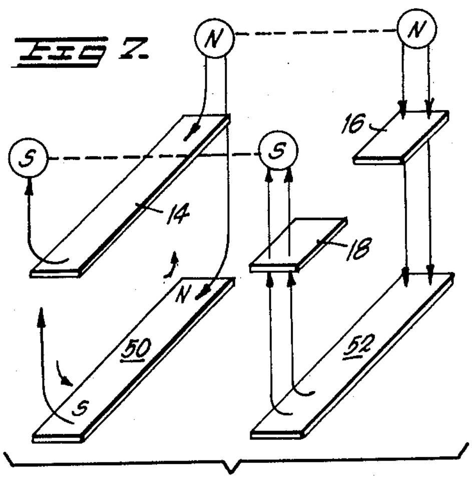
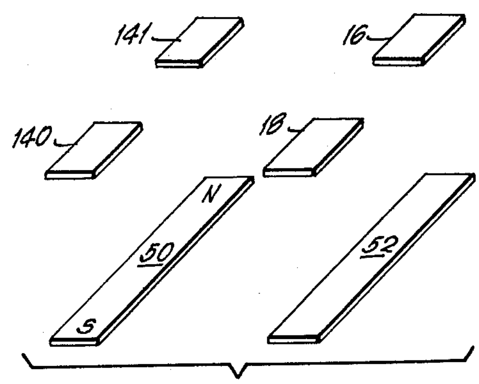


FIG. 8.



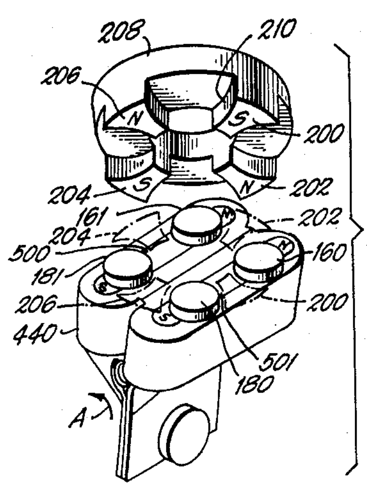


FIG. 9.

INVENTORS
DONALD E. REED
STANLEY F. REED

BY [signature]

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May 26, 1964 D. E. REED ETAL 3,134,870

PERMANENT MAGNET PROXIMITY SWITCH

Filed June 15, 1962 3 Sheets-Sheet 3

FIG. 10.

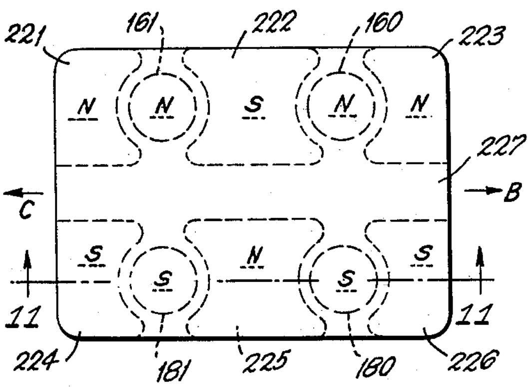
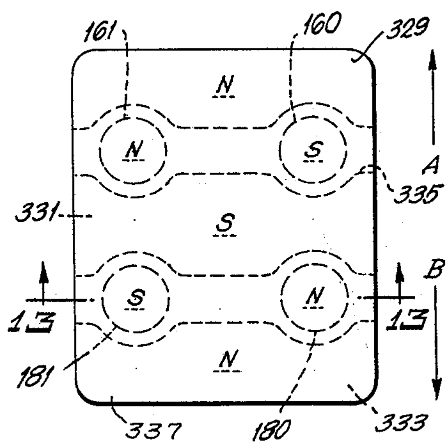


FIG. 12.



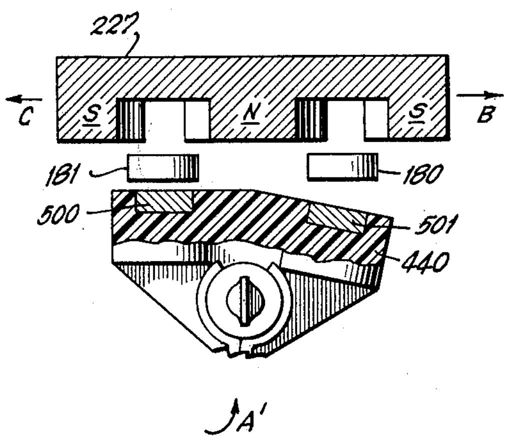


FIG. 11.

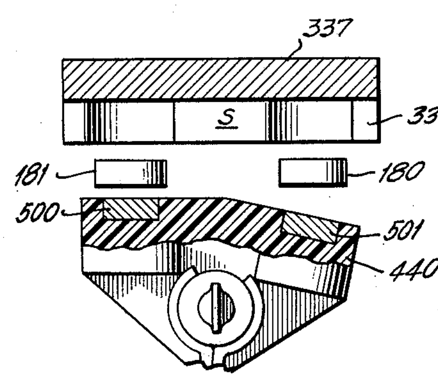


FIG. 13.

INVENTORS
DONALD E. REED
STANLEY F. REED

BY [signature]
ATTORNEY

United States Patent Office

3,134,870

Patented May 26, 1964

1

3,134,870

PERMANENT MAGNET PROXIMITY SWITCH

Donald E. Reed, Kensington, Md., and Stanley F. Reed, McLean, Va., assignors to Space Components, Inc., Washington, D.C., a corporation of the District of Columbia

Filed June 15, 1962, Ser. No. 202,824

18 Claims. (Cl. 200—87)

This invention relates to an electromagnetic snap action switch adapted to be actuated under the influence of a magnetic field.

According to one embodiment of the invention, an electromagnetic switch is magnetically biased to assume a quiescent or steady state position. Under the influence of an external magnetic field of sufficient strength, the bias is overcome and contacts of the switch assume a different configuration. The bias provides stability and the switch thus exhibits special utility in environments subject to vibration.

According to another embodiment of the invention, an electromagnetic switch carries a rotatable actuating magnet whose pole faces spacially mesh with a plurality of flux buttons on the switch, slight angular movement of the actuating magnet effecting actuation of the switch.

According to another embodiment of the invention, an electromagnetic switch carries a sliding magnet whose pole faces spacially mesh with a plurality of flux buttons on the switch, slight movement of the magnet effecting actuation of the switch.

The switch is characterized by the location of all moving elements and all electrical contacts in a completely controlled atmosphere. Typically, this is an inert atmosphere, but may be chosen as a reducing atmosphere. By such a construction, variations in switch operation which may be caused by variations in the ambient atmosphere are precluded.

In the drawings:

FIGURE 1 is a perspective view of the magnetic switch of this invention with an actuating magnet associated therewith.

FIGURE 2 is a view, partially broken, along line 2—2 of FIG. 1, the switch being in its quiescent state.

FIGURE 3 is a side elevational view of one component of the switch.

FIGURE 4 is a perspective view of another component of the switch.

FIGURES 5 through 7 are schematic illustrations of the operation of the switch of FIGURES 1 to 4 inclusive.

FIGURE 8 is a schematic view, similar to FIGURES 5 through 7, showing the operation of a second embodiment of the invention.

FIGURE 9 is a partially schematic view of a third embodiment of the invention.

FIGURE 10 is a top plan view of a fourth embodiment of the invention.

FIGURE 11 is an elevational cross-sectional view, partly schematic, of the embodiment of FIGURE 10.

FIGURE 12 is a top plan view of a fifth embodiment of the invention.

FIGURE 13 is an elevational cross-sectional view, partly schematic, of the embodiment of FIGURE 12.

Referring now to FIGURES 1 and 2 of the drawings, the numeral **10** denotes the magnetically actuated switch of this invention and includes a circular, flat cover plate **12** preferably of non-magnetic material such as non-magnetic stainless steel. Plate **12** is provided with inserts **14**, **16** and **18**, commonly termed flux buttons, of unmagnetized magnetic material of low retentivity. These inserts may extend completely through the plate **12**, as illustrated, or may be only partially imbedded. The inserts may be placed in the plate by soldering.

2

A generally cylindrical shell or wall **20**, preferably integral with plate **12**, terminates in a lower opening. Thus plate **12** and shell **20** define an open-ended cylindrical member. Preferably, shell **20** is formed of a non-magnetic material. In order to facilitate mounting of the switch the external surfaces of shell **20** may be threaded as indicated by the numeral **22** to facilitate insertion in a suitable mounting element.

The numeral **24** denotes a metallic ring which completely surrounds and is hermetically sealed to the periphery of a glass plate element **26**. Numeral **28** denotes a plurality of conductor elements **30**, **34** and **38** and a tubular vent element **40**, all of which pass through **26** in hermetically sealed relation. Conductors **30**, **34** and **38** are adapted to be inserted in a mounting socket and make electrical contact with an external circuit which is to be controlled by the switch. Conductors **30** and **34** terminate in flattened portions **35** and **37** respectively to which are affixed electrical contact buttons **32** and **36**. Conductor **38** extends higher than conductors **30** and **34** and terminates in a horizontally extending (note FIGURE 3) pivot element **42**.

Referring now to FIGURE 4 of the drawings, the numeral **44** denotes a pivotable body element having top faces **46** and **48** inclined to each other at an angle A (see FIGURE 2). A permanent magnet **50**, such as Alnico, is embedded in face **46** with one surface of the magnet preferably in the same plane as the face **46**. Magnet **50** has the polarity indicated although it will be understood that it may have the opposite polarity. The other face **48** of body **44** is provided with a block of magnetic material **52** not permanently magnetized also having one surface preferably in the same plane as its face **48**.

The numeral **51** denotes a bushing made of electrically conducting material, for example silver-graphite, extending completely through body member **44** and carries a longitudinal bore **53**. A pair of copper sheets **54** and **56** contact the sides of bushing **51** over a portion of the latter's circumference and extend downwardly side by side. Sheets **54** and **56** carry contact buttons **58** and **60** adapted to cooperate, respectively, with contacts **32** and **36** of the base of the switch. Rotary electrical contact is made between pivot **42** and the interior of bushing **51**. As shown at FIGURE 3, conductor **38** carries an abutment **39**, greatly exaggerated for purposes of illustration, against which the left end of bushing **51** abuts. A washer **41** bears against the right edge of the bushing. A suitable crimp **43** is made on the end of pivot stud **42** after **44** and **41** are placed thereon.

Preferably, the body **44** is formed of an insulating non-magnetic material, plastic having been found suitable. A plastic marketed under the tradename Dapon is acceptable since it does not give off gases at fairly high temperatures.

In assembly, all of the above described components are cleaned as by ultrasonic cleaning with a suitable solvent. Ring **24** is placed in the lower portion of shell **20** and silver solder S is applied and melted by induction heating. The ring **24**, with plate **26** therein, hermetically seals the interior of **10**, save for the vent tube **40**. The switch is placed in a vacuum oven and baked for four hours at a temperature of approximately 400° F. to remove all volatile contaminants. Dry nitrogen is now introduced into vent tube **40** and the interior of the switch is flushed with this nitrogen approximately three or four times. In the last filling of the interior of the device, a mixture of nitrogen (93 percent) and helium (7 percent) is introduced at a positive pressure (10–12 pounds gauge has been found suitable) at room temperature. The vent tube **40** is now sealed as by crimping or welding and solder may be added to the crimped portion if desired for more positive sealing.

In practice, "303 Stainless" steel has been found suitable as the cover member **12** and shell **20** and silver solder has been found suitable for placing the flux buttons **14, 16** and **18** in plate **12**, hermetically sealing them therein.

The switch has been found operable at temperatures up to 500° F. and will carry currents in the order of 15 amperes.

Referring now to FIGURES 5 through 7 of the drawings, the operation of the switch will now be given.

FIGURE 5 of the drawings illustrates, wholly schematically, the operation of the device to yield the quiescent position shown in FIGURE 2. The numerals at FIGURE 5 denote their corresponding three-dimensional counterparts of FIGURES 1 to 4 inclusive. Flux lines **100** and **102** emanating from permanent magnet **50** pass in the conventional direction as illustrated. These lines of flux find an easier path for return through element **14** than through flux buttons **16** and **18** since the latter are separated and are more distant from permanent magnet **50**. As well known to workers in this art, flux lines **100** and **102** tend to diminish in length and elements **50** and **14** exhibit an attraction for each other. This drawing together compels the body **44** to assume the illustrated position in FIGURE 2.

FIGURES 6 and 7 illustrate the operation of the magnetic switch of this invention under the influence of an external magnetic field such as supplied by magnet M of FIGURE 1.

Referring now to FIGURE 6, it will be assumed that an external actuating magnetic field has the indicated polarity, the dotted lines indicating that the illustrated N and S poles are from the same magnet. The flux lines emanating from the left portion of the external north pole divide, part going through the flux button **14** and part going through the magnet **50** in the indicated direction to the left portion of the external south pole. The flux lines emanating from the right portion of the external north pole pass first through flux button **18** thence through element **52** and thence through flux button **16** to the right portion of the external south pole to thus complete the magnetic circuit. Because nearly all of the magnetic flux lines from the right portion of the external magnetic field pass through element **52** while only a portion of the flux lines from the left portion of the external magnetic field pass through magnet **50** (the remainder of the flux lines from the left portion of the external magnetic field passing along the length of flux button **14**) there will be a greater upward force acting on element **52** than on permanent magnet **50**, if the strength of the external actuating field is sufficient to overcome the biasing action described with reference to FIGURE 5, and thus the body **44** will assume a position opposite to that illustrated in FIGURE 2 and contact **60** will now abut contact **36** thus forming a new electrical path through the switch.

Reference now to FIGURE 7 of the drawings illustrates that the position of the switch is changed from its quiescent or steady state position even though the polarity of the external magnetic field may be opposite to that illustrated in FIGURE 6. Nearly all of the magnetic lines of force emanating from the right portion of the external north pole pass through flux button **16**, element **52**, flux button **18** and thence return to the right portion of the external south pole. Nearly all of the flux lines from the left portion of the external north pole pass through flux button **14** and thence to the left portion of the external south pole. Few or none pass through permanent magnet **50** in the indicated direction, since it is both more remote than flux button **14** and the flux lines are in opposition to the field of permanent magnet **50**, as illustrated by the shortest curved lines. The upward force on element **52** will be greater than the upward force on element **50** because there are more flux lines threading through **16** and **18** and **52** than through **14** and **50** and the switch will assume a position opposite to that illustrated in FIGURE 2 and a new electrical path will be established in the switch.

It will be observed that the presence of the elongated flux button **14** also serves to protect the magnet **50** lying directly beneath. As apparent from the above discussion, no matter what the direction of lines of flux from the external actuating field, a portion of these flux lines always passes through flux button **14** thereby serving to weaken the effect or influence of these lines upon permanent magnet **50**. Thus, referring to FIGURE 7, in a case wherein the external field acts in a direction counter to the field of permanent magnet **50**, the presence of the flux button **14** serves to divert or divide the external flux lines thus weakening their effect upon magnet **50** and preventing it from becoming demagnetized.

In the description of FIGURES 6 and 7, it has been assumed that the external actuating field has been of a width to span the entire flux button array. Thus, in FIGURE 6, the north pole of the external actuating magnet has been assumed to be wide enough to span the distance from flux button **18** to flux button **14**, similarly, its south pole has been assumed to be wide enough to span the distance between flux button **16** and flux button **14**. In the preferred manner of operation, it is not necessary that the external actuating field emanate from such wide pole faces. Thus, referring to FIGURE 1 of the drawings, the external magnet M may lie directly over flux buttons **16** and **18** and not extend over flux button **14**. It will be clear, from the previous discussion, that if a narrower actuating field is employed acting directly above flux buttons **16** and **18** of FIGURES 6 and 7, the switch will be actuated away from the bias position whether it has the polarity indicated at FIGURE 6 or the polarity indicated at FIGURE 7 if the actuating field is strong enough.

FIGURE 8 of the drawings illustrates a second embodiment of the invention, similar in all structural respects to the first embodiment save for the presence of two flux buttons **140** and **141** in lieu of the single flux button **14**. Flux buttons **140** and **141** occupy the same positions as flux button **14** with respect to magnet **50** and plate **12**. In this embodiment of the invention, the magnetic saturation of element **52** is chosen to be greater than that of permanent magnet **50**. More flux lines from a sufficiently strong external actuating field will thence thread through element **52** than through magnet **50** regardless of the polarity, i.e., that of FIGURE 6 or that of FIGURE 7, of the external actuating field. Hence the quiescent biasing force, that due to the attraction between magnet **50** and flux buttons **140** and **141**, will be overcome and the switch actuated under the influence of the external actuating field no matter what its orientation if the strength of the external field is great enough.

FIGURE 9 of the drawings illustrates a third embodiment of the invention. Referring now to FIGURE 9, the numeral **440** denotes a body element similar in configuration to element **44** of the first embodiment. In lieu of a single permanent magnet **50** and an unmagnetized magnetic element **52**, two permanent magnets **500** and **501** are illustrated as occupying the same positions as elements **50** and **52** respectively (note FIGURE 4). Flux buttons **160, 161, 180** and **181**, occupy positions homologous to those indicated at FIGURE 8 of the drawings, the flux buttons being positioned in the cover plate **12**, the latter being omitted from the drawing for purposes of clarity. The numerals **200, 202, 204** and **206** denote pole faces of annular permanent magnet **208** having the indicated polarities. The dashed line representations of pole faces **200, 202, 204** and **206** show their positions relative to the other elements when permanent magnet **208** is in its operative position, i.e., its upper portion tilted toward the viewer so that its pole faces lie in a plane parallel to and slightly above the plane of the flux buttons. The pole faces are integral with the annular magnet **208** and extend downwardly therefrom as illustrated.

In order to actuate the magnetic switch of this embodiment, the magnet **208** (when in its operative position) is rotated counter clockwise. The pole faces will then occupy positions superposed with respect to the flux buttons. Thus, face **202** moves towards button **161**, face **200** moves towards button **160**, face **206** moves towards button **180** and face **204** moves towards button **181**. The flux lines emanating from face **206** pass through button **180** and then to the south pole of magnet **501**, thence to the north pole of magnet **501**, up through button **160** and enter magnet **208** through face **200**. Magnet **501** thus moves towards buttons **160** and **180** while the flux from faces **202** and **204** causes magnet **500** to move away from buttons **161** and **181**. The upper portion of body **440** thus rotates in the direction of arrow A. In order to reverse the rotation of body **440**, magnet **208** is rotated clockwise.

Upon return of annular magnet **208** to the illustrated central position (faces **206**, **200**, **202**, **204** not lying over but spaced between buttons **161**, **181**, **180**, **160**), the body **440** remains in the last position assumed, due to the greater flux passing from magnet **500** (or **501**) through the associated nearby flux buttons, as compared to flux from magnet **501** (or **500**) through the slightly more distant flux buttons.

Hence body **440** can assume either of two quiescent positions, the position assumed being dependent on the previous rotation of magnet **208**.

If desired, less than all of the pole faces **200**–**206** may be employed, although the operation is then somewhat less reliable.

The radius of the concave pole faces identified as **210** very closely approximates the radius of the flux buttons and hence only slight angular movement of magnet **208** is required to actuate the switch. Actuating magnet **208** may be mounted directly on the switch or it may be coupled to a shaft or other rotatable member fixedly positioned relative to the switch.

Referring now to FIGURES 10 and 11 of the drawings, still another embodiment of the invention is illustrated which employs a translating or sliding actuating magnet **227** in lieu of the rotary magnet **208** in the embodiment of FIGURE 9. Permanent magnet **227** has six pole faces **221**, **222**, **223**, **224**, **225** and **226** with polarities N, S, N, S, N and S, as indicated at FIGURE 10. When the actuating magnet is moved to the right, direction B, pole face **221** moves closer to flux button **161**, pole face **222** moves closer to flux button **160**, pole face **224** moves closer to flux button **181** and pole face **225** moves closer to flux button **180**. It will be understood that the flux buttons shown are mounted in plate **12**, in the same manner as in the embodiment of FIGURE 9. With movement of actuating magnet **227** to the right, north pole face **221** moves towards flux button **161** so that the flux emanating from pole face **221** passes through this flux button and repels the north pole N of magnet **500** situated in rotatable member **440**. Similarly, south pole face **224** moves towards flux button **181** and here also repulsion exists, now with the south pole S of magnet **500**. Hence magnet **500** is repelled from flux buttons **161** and **181**. South pole face **222** moves towards flux button **160** and the north pole N of permanent magnet **501** and attraction exists. Similarly, north pole face **225** moves towards **180** and the south pole S of permanent magnet **501** is attracted. This results in upward movement of magnet **501** towards flux buttons **160** and **180**. Thus rotation of the body **440**, indicated by A′ of FIGURE 11, occurs and the switch is actuated to a new position.

From the above described sequence, it is believed obvious that rotation in a direction opposite to A′ of FIGURE 11 will occur when actuating magnet **227** is moved to the left, direction C.

With actuating magnet **227** in a central position, i.e., the position indicated at FIGURE 10, the body **440** will remain in its last assumed position. The edges of the pole faces are so contoured as to closely complement the periphery of flux buttons **160**, **161**, **180** and **181**, as in the embodiment of FIGURE 9, so that only slight translating motion in either direction is required to effect the switch actuation.

From a consideration of this embodiment of the invention, it will be appreciated that if magnet **227** is rotated 90° such that flux button **180** lies between pole faces **224** and **225** and flux button **181** lies between pole faces **221** and **222**, etc., the actuation of body **440** is caused by motion of magnet **227** in the direction at right angles to the indicated directions B and C.

Referring now to FIGURES 12 and 13 of the drawings, still another embodiment of the invention is illustrated which employs another modification of a translating actuating magnet. Except for the reversal of the polarity of magnet **501** from the polarity shown in FIGURE 9, this embodiment is similar to the embodiments of FIGURES 9 and 10 save for the specific configuration of the actuating magnet. The numeral **337** denotes an actuating magnet adapted to travel along a path substantially parallel to the plane of flux buttons **160**, **161**, **180** and **181** placed in the plate **12** (not illustrated). Magnet **337** is provided with three ridge portions extending completely thereacross, the lower faces of which define magnetic pole faces **329**, **331** and **333** having the indicated polarities. Preferably, in order to effect switch actuation upon only slight movement of the actuator, the ridges include curved sides complementary to the flux buttons, one side of which is indicated by the numeral **335** in FIGURE 12. The poles of the permanent magnets which lie in body **440**, and which are situated below the flux buttons, have polarities as indicated at FIGURE 12 by N and S.

Referring now to FIGURE 12, upward motion shown by arrow A of actuator **337** causes pole face **333** to move closer to flux buttons **180** and **181**, similarly, pole face **331** moves closer to flux buttons **160** and **161**. Considering now the left portion of FIGURE 12, it will be seen that upward motion results in an attraction of magnet **500** carried by rotatable body **440** while magnet **501** also carried by rotatable body **440**, will be repelled. Thus the switch will be actuated. It is believed apparent that downward motion shown by arrow B will result in rotation of body **440** in a counter direction. The body **440** will remain in its last assumed position whenever actuating magnet **337** assumes a central position.

We claim:

1. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having three apertures therein, one of said three apertures being substantially larger than the other two of said three apertures, said apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said three apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, an elongated permanent magnet, a block of unmagnetized magnetic material, and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; and said armature so correlated to said cover plate that the larger one of said three inserts is positioned over said permanent magnet and said other two of said inserts are each positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said two electrical contacts supported by said shell.

2. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate

integral with said shell, said cover plate of non-magnetic material and having three apertures therein, and an insert of magnetic material sealed within each of said three apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a permanent magnet, a block of magnetic material, and an electrical contact mounted on said body element; an electrical contact mounted within said shell; and said armature so correlated to said cover plate that one of said three inserts is positioned over said permanent magnet and two of said inserts are positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

3. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having three apertures therein, one of said three apertures being substantially elongated and larger than the other two of said three apertures, said apertures being arranged to form a generally quadrangular configuration, with the elongated apertures along one side thereof, and an insert of magnetic material sealed within each of said three apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic insulating material, an elongated permanent magnet, an elongated block of unmagnetized magnetic material, said magnet and said block being aligned, and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; and said armature so correlated to said cover plate that the larger one of said three inserts is aligned with and positioned over said permanent magnet and said other two of said inserts are aligned with and positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said two electrical contacts supported by said shell.

4. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, an elongated permanent magnet, a block of unmagnetized magnetic material having a magnetic saturation greater than that of said permanent magnet, and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; and said armature so correlated to said cover plate that two of said four inserts are positioned over said permanent magnet and two of said four inserts are positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said two electrical contacts supported by said shell.

5. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a permanent magnet, a block of magnetic material having a magnetic saturation greater than that of said permanent magnet, and an electrical contact mounted on said body element; an electrical contact mounted within said shell; and said armature so correlated to said cover plate that two of said four inserts are positioned over said permanent magnet and two of said four inserts are positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

6. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic insulating material, an elongated permanent magnet, an elongated block of unmagnetized magnetic material having a magnetic saturation greater than that of said permanent magnet, said magnet and said block being aligned, and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; and said armature so correlated to said cover plate that two of said four inserts are aligned with and positioned over said permanent magnet and two of said four inserts are aligned with and positioned over said block of magnetic material, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said two electrical contacts supported by said shell.

7. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; and said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said two electrical contacts supported by said shell.

8. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a pair of permanent magnets and an electrical contact mounted on said body element; an electrical contact mounted within said shell; and said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets, whereby the application of an oriented magnetic field of a predetermined strength across said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

9. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a pair of permanent magnets and an electrical contact mounted on said body element; an electrical contact mounted within said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising an annular magnet having four pole faces depending therefrom, said pole faces spaced in a manner so that they may either be spatially positioned between said four inserts or superposed thereover, and so polarized that adjacent pole faces are of opposite polarity, whereby the rotation of said actuator with respect to said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

10. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising an annular magnet having four pole faces depending therefrom, said pole faces spaced in a manner so that they may either be spatially positioned between said four inserts or superposed thereover, so polarized that adjacent pole faces are of opposite polarity and so configured that the edge surfaces thereof closely conform to the configuration of the inserts adjacent thereto, whereby the rotation of said actuator with respect to said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said pair of electrical contacts mounted within said shell.

11. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of nonmagnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a pair of permanent magnets and an electrical contact mounted on said body element; an electrical contact mounted within said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having six pole faces depending therefrom, said pole faces spaced in two parallel lines of three each so that said pole faces may either be spatially positioned to surround said four inserts or four of said six pole faces be superposed thereover, and so polarized that adjacent pole faces are of opposite polarity, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

12. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of nonmagnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having six pole faces depending therefrom, said pole faces spaced in two parallel lines of three each so that said pole faces may either be spatially positioned to surround said four inserts or four of said six pole faces be superposed thereover, so polarized that adjacent pole faces are of opposite polarity and so configured that the edge surfaces thereof closely conform to the configuration of the inserts adjacent thereto, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said pair of electrical contacts mounted within said shell.

13. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a pair of permanent magnets and an electrical contact mounted on said body element; an electrical contact mounted within said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having three generally rectangular pole faces depending therefrom, said pole faces spaced so that said pole faces may either be spatially positioned to surround said four inserts or two of said three pole faces be superposed thereover, and so polarized that adjacent pole faces are of opposite polarity, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

14. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element; two electrical contacts mounted within and supported by said shell; said armature so correlated to said

cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having three generally rectangular pole faces depending therefrom, said pole faces spaced so that said pole faces may either be spatially positioned to surround said four inserts or two of said three pole faces be superposed thereover, so polarized that adjacent pole faces are of opposite polarity and so configured that the edge surfaces thereof closely conform to the configuration of the inserts adjacent thereto, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said pair of electrical contacts mounted within said shell.

15. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures, an armature rotatably mounted within said shell, said armature comprising a body element, a pair of substantially elongated permanent magnets and an electrical contact mounted on said body element, each of said pair of magnets having two ends with a north pole at one end and a south pole at the other end, said magnets aligned in parallel relation with the south pole of one magnet positioned adjacent the south pole of the other magnet, the poles thereof forming a generally rectangular configuration; an electrical contact mounted within said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over one of said pair of permanent magnets and the other two of said four inserts are positioned over the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having six pole faces depending therefrom; said pole faces spaced in two parallel lines of three each so that said pole faces may either be spatially positioned to surround said four inserts or four of said six pole faces be superposed thereover, and so polarized that adjacent pole faces are of opposite polarity, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

16. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures, an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of substantially elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element, each of said pair of magnets having two ends with a north pole at one end and a south pole at the other end, said magnets aligned in parallel relation with the south pole of one magnet positioned adjacent the south pole of the other magnet, the poles thereof forming a generally quadrangular configuration; two electrical contacts mounted within and supported by said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over the ends of one of said pair of permanent magnets and the other two of said four inserts are positioned over the ends of the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a rectangular magnet having six pole faces depending therefrom, said pole faces spaced in two parallel lines of three each so that said pole faces may either be spatially positioned to surround said four inserts or four of said six pole faces be superposed thereover, so polarized that adjacent pole faces are of opposite polarity and so configured that the edge surfaces thereof closely conform to the configuration of the inserts adjacent thereto, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said pair of electrical contacts mounted within said shell.

17. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell, said cover plate of non-magnetic material and having four apertures therein, said four apertures being arranged to form a generally quadrangular configuration, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within and supported by said shell, said armature comprising a body element of non-magnetic material, a pair of substantially elongated permanent magnets and a switch arm carrying a pair of electrical contacts mounted on said body element, each of said pair of magnets having two ends with a north pole at one end and a south pole at the other end, said magnets aligned in parallel relation with the south pole of one magnet positioned adjacent the north pole of the other magnet, the poles thereof forming a generally rectangular configuration; two electrical contacts mounted within and supported by said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over the ends of one of said pair of permanent magnets and the other two of said four inserts are positioned over the ends of the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising a generally rectangular magnet having three generally rectangular pole faces depending therefrom, said pole faces spaced so that said pole faces may either be spatially positioned to enclose said four inserts or two of said three pole faces be superposed thereover, so polarized that adjacent pole faces are of opposite polarity and so configured that the edge surfaces thereof closely conform to the configuration of the inserts adjacent thereto, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause one of said pair of electrical contacts on said switch arm to engage one of said pair of electrical contacts mounted within said shell.

18. In an electrical switch operable by a magnetic actuator, the combination comprising: a shell; a cover plate integral with said shell; said cover plate of non-magnetic material and having four apertures therein, and an insert of magnetic material sealed within each of said four apertures; an armature rotatably mounted within said shell, said armature comprising a body element, a pair of substantially elongated permanent magnets and an electrical contact mounted on said body element, each of said pair of magnets having two ends with a north pole at one end and a south pole at the other end, said magnets aligned in parallel relation with the south pole of one magnet positioned adajcent the north pole of the other magnet, the poles thereof forming a generally rectangular configuration; an electrical contact mounted within said shell; said armature so correlated to said cover plate that two of said four inserts are positioned over the ends of one of said pair of permanent magnets and the other two of said four inserts are positioned over the ends of the other of said pair of permanent magnets; and a magnetic actuator operatively associated with said cover plate and said armature, said actuator comprising generally rectangular magnet having three

generally rectangular pole faces depending therefrom, said pole faces spaced so that said pole faces may either be spatially positioned to enclose said four inserts or two of said three pole faces be superposed thereover, and so polarized that adjacent pole faces are of opposite polarity, whereby the translation of said actuator with respect to said cover plate will actuate said switch and cause said electrical contact on said body element to engage said electrical contact mounted within said shell.

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